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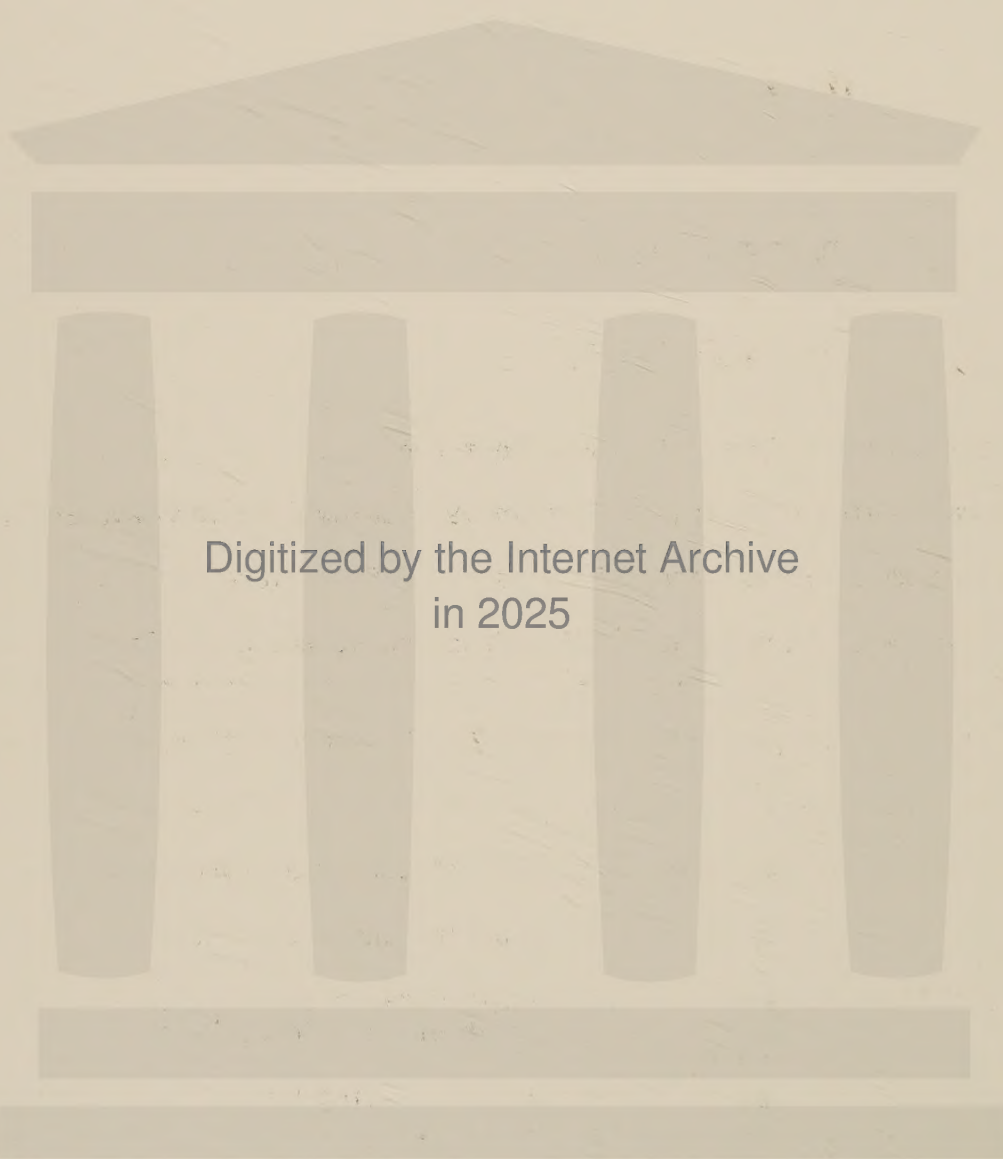
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SOUTHWEST FISHERIES CENTER

MONTHLY REPORT - DECEMBER 1976

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HONOLULU LABORATORY
LA JOLLA LABORATORY
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PACIFIC ENVIRONMENTAL GROUP

MONTHLY REPORT - DECEMBER 1976

STATUS OF PUBLICATIONS

Published

Steffel, Sherry, Andrew E. Dizon, John J. Magnuson and William H. Neill. 1976. Temperature discrimination by captive free-swimming tuna, Euthynnus affinis. Trans. Am. Fish. Soc. 105:588-591.

Captive kawakawa, Euthynnus affinis, were instrumentally conditioned to respond to an increase in temperature to determine discrimination abilities. Two fish yielded a discrimination threshold of 0.10 C. Thermal sensitivity of this high-sea pelagic fish is thus no more acute than that of inshore fishes and appears inadequate for direct sensing of weak horizontal temperature gradients at sea.

Approved by Center Director

Rosenblatt, Richard H. and John L. Butler. The ribbonfish genus Desmodema, with the description of a new species (Pisces, Trachipteridae). For publication in the Fishery Bulletin, U.S.

Barham, Eric G., Warren K. Taguchi and Stephen B. Reilly. Porpoise rescue methods in the yellowfin purse seine fishery and the importance of Medina panel mesh size. For publication in Marine Fisheries Review.

This report does not constitute publication and is for information only.

HONOLULU LABORATORY

RESOURCE ASSESSMENT AND DEVELOPMENT INVESTIGATIONS

Research Emphasis to be Redirected in Resource
Monitoring and Assessment Task

Task Leader Dr. Robert Skillman at the Honolulu Laboratory prepared Task Development Plans (TDP) for FY 1979 for the Resource Monitoring and Assessment Task (formerly Tuna Monitoring and Assessment Task). The name change reflects the greater emphasis that will be placed on the stock assessment of insular resources in the Northwestern Hawaiian Islands (NWHI), the main Hawaiian Islands, and areas of U.S. concern in the western Pacific Ocean. Dr. Skillman also searched the literature for stock assessment methodology studies pertaining to crustaceans, which may possibly be applied to the NWHI study.

Negotiations Continue on Details of NWHI Study

Dr. Skillman, coordinator of the NWHI study, reported that a new draft of the prospectus for the study was completed and mailed to the three major participants and to other interested parties. A meeting was held with representatives of the U.S. Fish and Wildlife Service (Messrs. Palmer Sekora, Refuge Manager; Charles Renda, Regional Solicitor; and Edward Smith, Pacific Coordinator) to discuss the new draft. Some valuable comments of a legal nature were received.

Also in connection with the NWHI study, Dr. Skillman (1) together with Laboratory Director Richard Shomura, met with Mr. John McMahon of the University of Hawaii's Marine Options Program to discuss the participation of undergraduate students in the various aspects of the NWHI field program, and (2) attended a meeting called by Mr. Shomura to scope out the Honolulu Laboratory's (HL) role in developing the lobster fishery in the NWHI. The discussion during the latter meeting included the collection of appropriate landings data, assessment of the resource, and the preparation of a preliminary management plan.

Work on Data Management System for NWHI Continues

Mr. Richard Uchida, Acting Task Leader, Insular Resources Program, continued to work with Mmes. Lucille Tsukano and Sally Kuba, in establishing a data management system for the NWHI. Included in this data base are catch reports of Hawaiian vessels that are presently engaged in handline fishing, trapping, and trolling in the NWHI. These vessels, however, are not identified on the IBM cards of the Hawaii Division of Fish and Game, because of the abandonment of vessel codes since mid-1972. Therefore, Mrs. Tsukano spent much of her time in December examining Fish and Game's vessel registrations and commercial fishermen's licenses and established an alphabetical list, by vessel name or owner, and a numerical list, by vessel code, for all Hawaiian vessels engaged in these fisheries. Mrs. Kuba continued working with the University of Hawaii Computing Center in

attempts to obtain three-dimensional plots of environmental variables such as thermocline depth, temperature and salinity by longitude and latitude for selected 5° squares around the NWHI.

* * * * *

Mr. Uchida completed a background document, "Summary of environmental and fishing information of the Northwestern Hawaiian Islands" and collaborated with Mr. Thomas Hida, Fishery Biologist, on a short report, "Preliminary results of lobster trapping in Northwestern Hawaiian Islands waters" for the Director's Office. Mr. Uchida also worked on FY 1979 TDP's for the Insular Resources Program.

* * * * *

At the request of Mr. Shomura, Dr. Skillman attended a meeting of the State of Hawaii Ad Hoc Marine Mammals Advisory Committee. Committee members discussed the potential problems of having innumerable "researchers" studying and photographing the humpback whales in the Maui area during the winter months. The committee also voted to disband and recommended that the Acting Marine Affairs Coordinator, State of Hawaii, form an advisory committee to the Marine Affairs Office to give the committee a more formal and powerful status.

* * * * *

Mr. Thomas Hida, who was chief scientist on Townsend Cromwell Cruise 76-06-73 (Leg 2) completed the cruise report and worked on the narrative report for the cruise. Mr Hida also supervised Research Assistants Arnold Suzumoto and Donald Majors, who are involved in the transfer of HL's fish and invertebrate collections to the Bishop Museum. Mr. Majors also completed a cruise report of a recent fishing trip of the Easy Rider to the NWHI. Mr. Majors accompanied the Easy Rider as an observer.

* * * * *

Research Assistants James Uchiyama and Paul Shiota were involved with "housecleaning" duties following the Cromwell cruise. Mr. Uchiyama curated the fish and invertebrate specimens collected during the cruise and Mr. Shiota serviced and stowed the gear used on the cruise.

Estimated Hawaii Catch of Skipjack Tuna in 1976 Below Long-Term Average

The November 22-December 19 Hawaii landings of skipjack tuna were estimated at 423.9 MT (metric tons), which is 385.4 MT above the 1975 landings for the same period and 301.6 MT above the 1948-1975 long-term average. The cumulative landings from January through December 19 were estimated at 4,009 MT, which is 1,734.5 MT above last year's landings for the same period but 285.4 MT below the average in 1948-1975.

* * * * *

Pulou Niuatoa, employee of the Government of American Samoa, recorded the lengths of 600 albacore from 12 vessels during the period from November 15 to December 17. He also collected 29 sets of catch and effort data.

FISH-ENVIRONMENT INVESTIGATIONS

Dr. Richard Barkley, Chief, FEI, completed revision of the manuscript, "Skipjack tuna habitat based on temperature and oxygen requirements," by R. A. Barkley, W. H. Neill, and R. M. Gooding, following non-HL scientists' review. The manuscript is being retyped for submission to the SWFC Director for approval.

LA JOLLA LABORATORY

Coastal Fisheries Resources Division

ALBACORE FISHERIES PROGRAM

Report of Joint NMFS/AFRF Albacore Studies in 1976 Completed

Dr. Michael Laurs, Leader of the Albacore Investigations Group at La Jolla, reported that the staff has completed the "Report of Joint National Marine Fisheries Service (NMFS)/American Fishermen's Research Foundation (AFRF) Studies Conducted During 1976." This 51-page administrative report deals with four topics:

- a) Cooperative NMFS/AFRF early-season offshore studies, 1976;
- b) Food habits of albacore caught in offshore waters during 1976;
- c) Albacore scouting and research activities, 1976 season, and
- d) Joint NMFS/AFRF albacore tagging study.

The first 3 items were covered in the November monthly report. The following material deals with the results of the tagging work.

Tagging Studies

A total of 1526+ albacore was tagged and released during the 1976 charter operations, 530 during the early-season in offshore waters, and 996 during the season. Independent boats also tagged albacore in cooperation with NMFS in 1976, but only a partial listing of tagged fish released by these boats has been received. Over 10,000 fish have been tagged and

released since the start of the joint NMFS-AFRF albacore tagging study. A summary, by year, of the number of fish tagged and released, recovered, and percent recovery, are given below:

Summary by year of number of albacore tagged and released, recovered, and percent recovery for joint NMFS-AFRF albacore tagging program

Year	Number tagged fish released	Number tagged fish recovered	Percent recovery
1971	887	33	3.7
1972	2,082	175	8.4
1973	1,806	108	6.0
1974	2,490	138	5.5
1975	1,351	78	5.8
1976	1,526	15	0.9
Total	10,142	547	5.4

During 1976, up to October 31, 103 tagged albacore have been recovered, 55 by U.S. commercial boats, 23 by U.S. sportsboats, 1 by a Mexican purse seiner 19 by Japanese baitboats, 3 by Japanese longliners, and 1 by a Japanese purse seiner. Of the 103 recoveries, 2 were from fish tagged in 1972, 1 from fish tagged in 1973, 26 from fish tagged in 1974, 59 from fish tagged in 1975, and 15 from fish tagged in 1976. A summary of the number of tagged fish recoveries made by year and breakdown by the year that recovered fish were tagged and released follows:

Summary of albacore tagged and released and recovered by years¹

Year released	Year Recovered					
	1971	1972	1973	1974	1975	1976
1971	0 ²	15	11	6	0	0
1972	-	78	71	21	2	2
1973	-	-	13	60	33	1
1974	-	-	-	36	75	26
1975	-	-	-	-	18	59
1976	-	-	-	-	-	15

¹ There have been five recoveries made for which the year of recovery is unknown.

² Tagging done in October 1971 near end of season.

Recoveries Made by U.S. Boats of
Fish Tagged in 1976

Fifteen recoveries were made of albacore tagged and released during 1976. One of these was tagged in offshore waters in the third week of June and the remainder were tagged in nearshore waters during the normal fishing season. Eight of the recoveries were made off Baja California, three were made off central to northern California, and two off the Pacific Northwest.

The release-recovery pattern is similar to that observed in other years. Fish tagged off Baja California tended to remain in the general area where they were tagged until about late September and October.

Each of the recoveries made off California was i) tagged off California, ii) at liberty about 1 to 2 months, and iii) showed different directions of movement. One of the tagged fish recovered in Pacific Northwest waters was tagged west of the Columbia River and recovered west of Cape Flattery about 2 months later. The other recovery made off the Pacific Northwest was tagged in offshore waters at 38°N, 139°W on June 21 and recovered off northern Washington 10 weeks later.

Recoveries Made by U.S. Boats in 1976 of Albacore
Tagged and Released in 1975 and 1974

Fish tagged and released in 1975 and 1974 and recovered in 1976 tended to be recovered in the general area which they had been released one or two seasons earlier. For example fish recovered, with two exceptions, were tagged and released in inshore waters north of about Cape Mendocino the year before. Fish which were recovered off central and southern California in 1976 after being at liberty since the previous season, were tagged and released in inshore waters off central California. Finally, most of the albacore which were recovered off Baja California in 1976, after being at liberty since the previous season, with the exception of one fish which was tagged just north of Cape Mendocino, were tagged and released in inshore waters off central and southern California and off Baja California. In addition, two of the recoveries made off Baja were tagged in offshore waters the year before.

These recoveries show that the albacore that were in the northern and southern regions of the North American west coast fishery during 1975 tended to return to these same regions in 1976. Although the number of recoveries made in 1976 of fish tagged two seasons earlier in 1974 was small, the data show similar results. Similar results were also found in earlier years of the cooperative NMFS/AFRF albacore tagging program.

Although tag recoveries show that there are some crossovers from region to region over one year, evidence suggests that there is a regional separation of albacore found off the North American coast and that two geographically separated groups of fish comprise the North American albacore fishery.

STOCK AND RECRUITMENT PROGRAM

Retrospective View of Marine Larval Fish Research at the La Jolla Laboratory - 1976

The causes of marine larval fish mortality and its effect on recruitment have become increasingly important areas of study in fishery science. At the La Jolla Laboratory, larval fish studies are concentrated in the Coastal Fisheries Resources Division where they have been applied to the stock and recruitment relationship, to the determination of fish population biomass, and to the distribution of important commercial and recreational fish species in the Pacific Ocean. The Southwest Fisheries Center's La Jolla Laboratory has long been recognized as a center of expertise in larval fish research. Thus year's end it is appropriate to review highlights of a number of fruitful areas in larval fish research which were investigated by Dr. Reuben Lasker, Coastal Fisheries Resources Division Leader, and his staff during the past year: histology of starvation of larvae; oceanographic changes which affect the distribution of larval fish food; the determination and analysis of the kinds of food and feeding by larval northern anchovy, jack mackerel and Pacific sardine; analysis of mortality rates of northern anchovy embryos and larvae from 1951-1969 from CalCOFI data; the development of techniques for assessing the suitability of various water masses as feeding grounds for fish larvae; an investigation into invertebrate and vertebrate predators of fish larvae; simulation modeling of larval anchovy growth, behavior and prey microdistribution; the application of otolith aging techniques to larval anchovy growth studies; and food chain studies of pesticide uptake by larval anchovies.

All of these studies have been aimed at understanding how pelagic fish larvae cope with their environment; ultimately, the data generated are intended to elucidate the vital stock and recruitment relationship.

Drs. P. Smith and R. Lasker, Fishery Biologists, were invited participants to the Joint Oceanographic Assembly in Edinburgh, Scotland, in September 1976 where they presented papers to plenary symposia on their larval fish research. The first of these, authored jointly by Drs. Smith and Lasker, "Position of larval fish in an ecosystem," gave first order estimates of distribution, abundance, growth and survival rates of northern anchovy larvae and showed how this information could be used to analyze the causes of anchovy larval mortality. By examining seasonal and annual variations in the degree of anchovy spawning against sea surface temperature, vertical temperature gradients, upwelling, the speed of the California Current, the flushing rate of the Los Angeles Bight and secondary production, they showed that the usual habit of the anchovy to spawn heavily in the southern California area in winter alters radically in some years. The results indicated that spawning appears to be a simple function of the biomass of adults and the annual record reflects little more complexity than the rapid increase in anchovy biomass over the past 25 years. Dr. Lasker's paper, "The relation between oceanographic conditions and larval anchovy food in the California Current: identification of factors contributing to

recruitment failure," gave supporting evidence for his recent hypothesis that upwelling events and storms in the California Current are detrimental to anchovy larvae by diluting concentrations of their food. He predicted the 1975 year class of anchovy to be a very poor one, based on the occurrence of massive upwelling in the Los Angeles Bight during the anchovy spawning season and the poor nutritional content of the dominant larval fish food organism (Gonyaulax polyedra) present before upwelling occurred. This has been borne out by subsequent fishery analysis by the California Department of Fish and Game.

Under a grant from the Brookhaven National Laboratory of ERDA, Drs. E. Scura, Physiologist, and R. Lasker initiated studies of larvae of winter flounder (Pseudopleuronectes americanus), summer flounder (Paralichthys dentatus), and scup (Stenotomus chrysops) in the New York Bight with the assistance of Dr. Geoffrey Laurence of the Narragansett laboratory of NMFS and Ms. K. Dorsey, Biological Technician at the La Jolla Laboratory.

Tests with first-feeding flounder, scup and anchovy larvae showed that with certain modifications, each species can be used as a bioassay to determine whether feeding conditions in a body of water are right for a particular species of fish larva. For example, anchovy larvae require approximately 280, 50 μm diameter particles a day, whereas flounders and scup are competent feeders on larger particles when they begin to feed and require only 10, 150 μm diameter or even fewer larger particles to satisfy their metabolic requirements. The work of Dr. J. Hunter has shown that larvae are extremely inefficient in capturing their food when they begin to feed, whereas scup and flounder seem to be slightly more efficient. Preference for certain kinds of food are evident in all species examined thus far. Thus, high levels of spiniferous dinoflagellates (Ceratium tripos) were ignored by flounder and scup larvae in the New York Bight during November and June, respectively, whereas nauplii and dinoflagellates (e.g., Prorocentrum) were taken by flounder, provided the nauplii and dinoflagellates were in concentrations higher than 100/liter. Scup preferred a smaller dinoflagellate, Dinophysis acuminata, to the larger Ceratium despite the predominance of the latter, while anchovy larvae in the Los Angeles Bight will not eat small diatoms, regardless of their abundance. An unusual finding was that scup larvae selected pine pollen grains, despite the extremely low concentration (.01-.04/l) of pollen in New York Bight water during June 1976.

Based upon the successful bioassay technique and survey methods for particle concentrations needed by anchovy larvae in the Los Angeles Bight, a plan has been developed by Dr. Lasker for the Energy Research and Development Administration to study larval fish mortality in the New York Bight patterned after work instituted in the California Current. This includes monthly surveys with sampling for larval fish food distribution and measurements of oceanographic conditions to correlate with microdistribution of larval fish food and the vertical distribution of the larvae. The basic elements of an investigation into larval fish mortality depend on the ready

availability of spawning fish in laboratory tanks, physiological information on larvae of the important commercial species, and the determination under a variety of conditions of the behavioral responses of larvae to their food as is currently done at the La Jolla Laboratory. This may be followed by field bioassays with laboratory produced larvae to determine where and under what conditions concentrations of larval food are available to the species under investigation.

Two instruments have been developed in conjunction with the studies of larval fish food patchiness in the New York and Los Angeles Bights to determine in situ concentrations of phytoplankton and microzooplankton (<1 mm in smallest dimension). A prototype model of a free-fall particle counter has been developed by Mr. J. Brown, electronic technician, and will undergo testing in the spring of 1977. This instrument is intended to be a survey instrument for rapid measurement of in situ stratification and the distribution of particles by size throughout a 100 m column. A dedicated computer accumulates numbers of particles per unit volume by 0.2 m strata and by size of particle. The second instrument, already used successfully in the New York and Los Angeles Bights, was developed by Dr. Scura. It is deployed on a ship's hydrowire and provides information on relative particle distribution (between 50 and 500 μ m) with depth using a rate meter. Water is delivered on board to provide specific particle concentrations when this is desired. The actual size and number of particles per unit volume is determined with a model Ta Coulter Counter aboard ship. Species composition is determined with an inverted microscope later in the laboratory from preserved samples.

An interdisciplinary, multi-ship cruise under the leadership of Drs. R. Lasker and R. Owen, oceanographer, was conducted in March 1976 with the NOAA research vessels David Starr Jordan (based in San Diego) and Townsend Cromwell (based in Honolulu) to study the microdistribution of small planktonic organisms used as food by fish larvae in California coastal waters. Samples taken during this cruise with a 10-bottle vertical sampler have been analyzed by Dr. Owen for fine-scale depth differences in phytoplankton concentration, phaeophytin, detritus and microzooplankton patchiness. Because of the small distances first-feeding anchovy larvae can travel, this fine-scale distribution in their food may be critical to larval survival. Dr. Owen found, for example, that adjacent bottles, 0.2 m apart, can differ in phytoplankton content by as much as two times in the chlorophyll maximum layer. Horizontal patchiness was also investigated by constantly sampling with a plankton pump from two ships simultaneously as the ships approached one another. These data are being analyzed at this writing.

Unique to the program at the La Jolla Laboratory is the ability to mature and spawn at will important pelagic marine fishes to provide fish eggs and larvae for experimentation. Five important species have been successfully matured and spawned in the SWFC aquarium--the northern anchovy, Pacific sardine, Pacific mackerel, striped bass and Gulf croaker. Accepted for publication this year is the paper by Fishery Biologist R. Leong which presents a technique for the maturation and induced spawning of captive Pacific

mackerel, Scomber japonicus. All of the experimental work on larvae at the laboratory now depends on techniques developed by Mr. Leong to provide living material.

To provide the physiological information essential to our understanding of how much food fish larvae need in the sea, Dr. J. Hunter, assisted by Ms. C. Sanchez, biological technician, completed a study of the incubation time, rate of yolk absorption, onset of first feeding, and effects of starvation on survival, growth and food size requirements for Pacific mackerel larvae. They determined that in order to survive and grow, Pacific mackerel larvae must feed on progressively larger prey as they grow, unlike the anchovy which can maintain itself on small particles until it is 6-7 mm in size.

Dr. Hunter and Ms. Sanchez completed laboratory and field studies which demonstrated that >10 mm larval anchovies inflate their swim bladders each night and deflate them in the day. By swallowing air at the surface, the larvae could reduce their energy expenditure at night by floating and not swimming until the next morning.

Dr. Hunter also completed a study on the laboratory culture and growth of northern anchovy larvae. He found that growth in the laboratory on a number of cultured foods was equivalent to growth on a wild plankton diet. A significant finding was that Artemia salina nauplii could only be used as a food for larvae after the larvae had acquired a loop in their intestines as a precursor to the formation of a stomach. Without this loop, Dr. Hunter believes that the larvae do not retain the Artemia nauplii long enough to digest them and hence starve to death.

Until now, it has been impossible to relate the larvae caught in plankton nets to any criteria which could indicate what proportion of them are doomed to die. With the advent of an otolith aging technique for fish larvae, developed last year at the La Jolla Laboratory, it is now possible to assess whether larvae in the ocean are growing optimally or not. Mr. D. Kramer, fishery biologist, with the assistance of Mr. K. Plummer, recently completed a study of aging of anchovy larvae collected at sea by counts of daily increments on their otoliths. Although the larvae were collected at 15° to 16°C, the larvae had a growth rate comparable to those reared at 14°C in the laboratory, indicating that food was limited for these larvae in the sea. In July 1976 the Coastal Division hosted a Workshop on the use of otolith aging techniques for studying growth in fishes; Mr. Kramer was a convenor of this Workshop.

From a different point of view, Dr. C. O'Connell, fishery biologist, developed histological criteria to determine the extent of starvation-induced emaciation in early post yolk-sac larvae of the northern anchovy. He used a stepwise discriminant analysis of various tissue conditions and determined that an average grading of 3 or 4 characteristics could be used to determine whether a larva was starving in nature.

Using a similar discriminant analysis, Ms. G. Theilacker, fishery biologist, studied jack mackerel larvae and was able to relate five externally measured morphometric parameters to the histological features of starvation. These morphological measurements may be a very sensitive diagnostic method for determining whether field-caught specimens of jack mackerel larvae are in a state of starvation.

Dr. D. Arthur, NOAA Research Associate in the Coastal Division, has been studying the physical condition of all sizes of anchovy larvae using the relationship of body depth to length from CalCOFI samples from the years 1963 and 1965; 1963 was a very good year for larval anchovy survival while 1965 was a comparatively poor year. Dr. Arthur is attempting to correlate the distribution of larvae in good and poor physical condition with the oceanographic conditions for those years. He has found that 6 mm larvae show differences in physical condition which can be correlated with the good and poor survival years; he has also found striking differences in larval condition between very nearshore and offshore areas in the same year.

Dr. W. Vlymen, NOAA Research Associate until June 1976, completed a mathematical model of the relationships between larval anchovy growth, prey microdistribution and larval behavior. This simulation showed that nonlinear growth rates are functions of prey contagion, but that the highest growth rates do not occur at the highest levels of contagion, an unexpected finding.

A study made by Dr. Arthur showed that there is a distinct difference in the number of microcopepods from onshore to offshore in the California Current. Twelve times as many nauplii per unit volume, on the average, occur near the shore as in the offshore zone. Highest densities found were 195/liter with an average of about 36/liter at those stations with the highest numbers. While the mass of an individual nauplius increased exponentially with increase in nauplius size, the numbers of nauplii decreased exponentially with size. A naupliar biomass maximum was found to occur with organisms 70 μ m in width. Nauplii of this size are ingested at first feeding by sardine, anchovy and jack mackerel larvae. Dr. Arthur believes that most larval fish have developed feeding tactics to utilize this small but important food resource at first feeding.

To test whether there is sufficient contagion of nauplii and other microzooplankters to sustain anchovy larvae of 6 mm in length and larger, Dr. Lasker, with Ms. M. Pollock, biological technician, and Dr. C. Barry have extended their research to include a bioassay at sea with laboratory-grown 6 mm anchovy larvae. Dr. Hunter noted earlier that once anchovy larvae reach 6 mm in length, feeding by larvae on small particles such as 50 μ m dinoflagellates resulted in an energy deficit. Therefore, 6 mm anchovy larvae must eat larger particles as well as small particles in order to maintain their metabolism and grow. At year's end, this biomass technique was being developed for testing in the spring of 1977.

An analysis of growth of larval fishes has been an important part of all the physiological studies made at the Southwest Fisheries Center. This year, Mr. J. Zweifel, mathematician, and Dr. Lasker published an account of a general mathematical model applicable to pre-hatch and post-hatch growth of fishes. They found that the development stages of fish eggs and the growth of larval fishes of several species can be represented by a Gompertz-type curve based on the observation that in widely different living systems, exponential growth tends to undergo exponential decay with time.

Recognizing that a major cause of larval mortality may be the abundance of predators in the California Current Region, Dr. A. Alvarino, fishery biologist, has been analyzing the plankton collections of the monthly CalCOFI cruises for 1954, 1956, and 1958 for Chaetognatha, Siphonophorae, Medusae, Ctenophora, Chondrophorae, and other zooplankters. Each species is identified and the number of individuals per species counted and measured. Data are also obtained on the number of organisms containing food in their digestive tracts. The food organisms are identified as well as their relative abundance in the sample. Dr. Alvarino has found that fish larvae, copepods and euphausiids appear in the digestive tract of planktonic predatory species even though they may be absent or scarce in the same planktonic collection. Sixty percent of the invertebrate predators found with food in their stomachs were found to have eaten fish larvae. Chaetognaths more frequently contain older larvae rather than yolk sac individuals. This may be because Chaetognaths digest yolk sac larvae very rapidly or that Chaetognaths can capture older fish larvae more successfully.

A UNESCO fellow at the Southwest Fisheries Center, Dr. V.P. Nair, under the direction of Dr. Alvarino, conducted rearing experiments in the laboratory on the neritic Chaetognath, Sagitta euneritica, and found that the species fed efficiently on fish larvae. Dr. Alvarino was invited to and lectured on her work at various Mexican, Central American and South American symposia and congresses in 1976.

Dr. J. Hunter also has been evaluating the impact of cannibalism by adult anchovy on their own eggs and larvae. His laboratory study indicates that predation by adults on their own spawn can be substantial and may be an important cause of mortality.

In May 1976, the National Marine Fisheries Service published as a Circular (No. 395), the report of a Southwest Fisheries Center Colloquium on larval fish mortality studies and their relation to fishery research. Dr. J. Hunter edited this report which outlined what is known about larval fishes as related to recruitment and what scientists can expect to learn by studying them in the laboratory and in the field. A number of research recommendations were proposed by the Colloquium participants and these have guided larval fish research in a number of fishery laboratories throughout the world.

Various government agencies have recognized the utility of using pelagic fish eggs and larvae for determining the effect of pollutants in the environment and have requested the involvement of the Stock and Recruitment Program of the Southwest Fisheries Center to assist them. As part of a study supported by the National Science Foundation, International Decade of Ocean Exploration (IDOE), Dr. Scura and Ms. Theilacker used anchovy larvae and their cultured foods to determine the quantitative transfer of chlorinated hydrocarbons (DDT, PCB) from sea water to the larvae. This work was the first of its kind where the concentration of chlorinated hydrocarbons was the same as one finds in natural sea water. They concluded that unfed larvae did not differ from larvae which have been fed organisms suspended in contaminated water because the accumulation of chlorinated hydrocarbons was not a good phenomenon but rather the result of direct partitioning of the organic compounds between the sea water and the larvae.

At the end of 1976, the Environmental Protection Agency (EPA) awarded a contract to the Southwest Fisheries Center to study the lethal or detrimental effects of ultraviolet (UV) radiation of fish eggs and larvae. Although water transmits little UV radiation, many fish eggs and larvae (e.g., northern anchovy) float so close to the surface that increased levels of UV radiation could be detrimental or lethal. EPA is concerned with the diminution of the earth's ozone layer due to high flying jet aircraft and the subsequent increase in UV radiation.

For 25 years, the Southwest Fisheries Center has been a partner in the California Cooperative Oceanic Fisheries Investigation (CalCOFI) with Scripps Institution of Oceanography and the California Department of Fish and Game in determining the biomass of important commercial pelagic fishes by sampling their eggs and larvae through entire spawning seasons. The analysis of these results also has permitted Dr. Smith to provide mortality estimates for larvae from year to year and biomass estimates for specific species, notably the northern anchovy, Pacific sardine, jack mackerel, Pacific mackerel and hake. In 1976, the information obtained by CalCOFI cruises on the distribution of fish eggs and larvae has been corrected for biases inherent in the sampling and provided in table form by Dr. Smith for use in corrected biomass estimates.

There is a continuous analysis by Dr. Smith and Mr. J. Zweifel of the errors involved in using the numbers of larval fish caught by plankton nets for biomass estimates. Most recently, Mr. Zweifel has devised a weighted negative binomial model which eliminates most of the difficulties inherent in normalizing and linearizing larval catch data. He has devised a maximum likelihood estimate method for analyzing data collected in samples from contagious natural populations (e.g., eggs and larvae) when the vulnerability to capture is not constant. This discrete model permits the use of all plankton tows, and unlike analyses based on continuous distributions, shows that the number of tows in which no eggs or larvae would be expected is easily predicted from the model parameters. In addition, Mr. Zweifel has derived confidence intervals for the negative binomial distribution and showed that precise probability statements are possible for a wide range of sampling situations.

ECOLOGY OF THE CALIFORNIA CURRENT

From the inception of the Southwest Fisheries Center and its predecessors, multispecies taxonomy of larval fishes has been an important part of the research program because no other studies could have been made on these organisms unless scientists knew what species were present in the California Current and how to identify them. Dr. E. Ahlstrom, Dr. H.G. Moser and their coworkers are world-renowned for their scientific expertise on the taxonomy and natural history of larval fishes from the world's oceans. They have compiled and curated an extensive reference collection used by fishery scientists from many nations for identification of larval fish. In addition, Dr. Ahlstrom has conducted classes for NMFS and foreign scientists on the taxonomy of larval fishes and in this way provided many fishery laboratories with the information needed for conducting larval fish research. This year has been a particularly productive one for this group. Dr. Ahlstrom's lectures from his class are being transcribed for a book which will contain extensive and precise illustrations of eggs and larvae for which his publications have been noted. The recent interest in rockfish off California illustrates the importance of Dr. Moser's work which now permits us to determine which species of rockfish are dominant spawners in nearshore California waters and when they spawn. A study using Dr. Moser's species identifications will be carried out next year by Mr. J. MacGregor who will attempt to estimate spawning biomass of rockfish in the southern California area using the larvae caught during past CalCOFI cruises.

Last year, Drs. Ahlstrom and Moser completed a CalCOFI atlas on the distribution of flatfish larvae. This is the fifth larval fish atlas produced by Dr. Ahlstrom and his group since 1968, and provides for the most complete larval fish distribution series in the world. This year, a sixth atlas has been in progress, a distributional atlas of rockfish larvae (Sebastes spp.) for the years 1951-1969.

A major publication put out by this group during 1976 was titled, "Pelagic stromateoid fishes of the eastern Pacific: kinds, distributions, and early life histories and observations on five of these from the Northwest Atlantic," by E. Ahlstrom, J. Butler and B. Sumida. Complete life histories are given for 11 species and less complete ones for 8 species. Another major manuscript completed in 1976 and now in press is a "Guide to the identification of scorpionfish larvae (family Scorpaenidae) in the eastern Pacific" by H.G. Moser, E. Ahlstrom and E. Sandknop.

Dr. Ahlstrom was an invited speaker at the Second European Ichthyological Congress in Paris in September 1976. The paper presented by Dr. Ahlstrom (a joint contribution with Dr. H.G. Moser) was titled, "Eggs and larvae of fishes and their role in systematic investigations and in fisheries."

Dr. Ahlstrom's unit at the Southwest Fisheries Center is responsible for the identification of fish eggs and larvae taken on CalCOFI surveys, and furnishes the information used by Dr. P. Smith in making biomass estimates of Pacific mackerel, jack mackerel, saury and other fish resources.

This year has seen an increased use of larval fish information in establishing criteria for the management of pelagic fish species. For example, negotiations by the Northwest Fisheries Center with the Soviets and the Poles have been based on information provided by Dr. Smith for trends in hake eggs and larvae capture. Dr. Smith showed that from a time series of estimated larval hake abundance that the peak abundance of hake was in 1956 with a smaller secondary peak in 1966. Since the Soviet fishery began in 1966, there has been a continuous decline apparent in the abundance of larval hake, as well as an apparent shift in the distribution of spawning. Hake spawning south of Ensenada has been strongly curtailed since 1965. This information was used to suggest that catches of hake should be reduced to permit a recovery of the stock.

Biomass estimates of northern anchovy derived from egg and larva data are still the prime sources for information used to manage the northern anchovy fishery between Mexico and the United States. This year, the California Department of Fish and Game has relied heavily on the larval time series to indicate fluctuations in the major population. The most recent plan presented to the Fish and Game Commission of the State of California to increase the commercial fishery on the stock was derived from larval abundance estimates produced at the Southwest Fisheries Center. In the past, moratoria on fishing of the Pacific mackerel and Pacific sardine stocks was a direct result of scientific evidence provided to the Fish and Game Commission from egg and larva data as well as from small fish surveys run by the California Department of Fish and Game.

NMFS Participates in Cooperative Assessment of Northern Anchovy Resource

Three research vessels, the NOAA ship, David Starr Jordan, the California Department of Fish and Game, Alaska and the Instituto Nacional de Pesca (National Fishery Institute) Alzate from Mexico, combined their staff and resources in an effort to assess the numbers and extent of the northern anchovy resource during a hydroacoustic survey of the area between Pt. Dume, California and Cape Colnett, Baja California, during the period, December 6-21.

Both the U.S. and Mexico are presently harvesting the northern anchovy which moves back and forth across the border. California commercial fishermen took 141,000 tons of anchovy during the 1975-1976 season, while Mexico has indicated its intention to increase considerably its catch of anchovy for reduction to fish meal. Present estimates of the central stock of the anchovy population, based on previous egg and larva surveys off California and Baja California indicate a resource of approximately 4 million tons.

Based on reports from U.S. and Mexican commercial aerial fish spotters, the three ships rendezvoused in an area of high fish concentration to conduct acoustic surveys along pre-determined lines during daylight hours. All three ships trained their sonar beams on the same targets. One important objective of the joint operations was to attempt to standardize or

intercalibrate the strength of the response between the various sonar systems operating aboard the vessels as it relates to the targets. At the same time, the ships, put out their trawl nets to take fish samples to confirm their sonar findings.

While the ships engaged in these operations, Fishery Biologist James Squire of the La Jolla Laboratory flew overhead in an aircraft chartered by the National Marine Fisheries Service, to help provide another check on the identity of the fish schools.

The Jordan was equipped for this cooperative cruise with a net sonde (a device for relaying information on the fishing depth of the trawl, since it is essential to know where the fish catch was made relative to the water column), and a new trawl, modified by a FAO technician in Mexico, which has a large mouth opening to catch fish more efficiently and with improved filtering capacity. The acoustics gear, fully computerized, operates automatically while the Jordan is underway.

Information from this cooperative cruise will be analyzed by fisheries scientists of NMFS, California Department of Fish and Game and INP to provide a common scientific understanding for the U.S. and Mexican fisheries on the common stock. Any bilateral fisheries agreement between the U.S. and Mexico will require cooperation between scientists of both countries in developing knowledge of shared fisheries and fisheries resources.

New Sonar Techniques Tested on Jordan

Routine identification of fish and estimation of their individual size by acoustic means has not yet been developed to a useful stage. A step toward this goal, however, has now been reported by Dr. Paul Smith, Leader of the Ecology of the California Current program at the La Jolla Laboratory and Mr. Roger Hewitt, NOAA Corps officer on detail to the La Jolla Laboratory. With Dr. D.V. Holliday of the Tracor Sciences and Systems Co. with whom NMFS has contracted to determine what sizes and species of fish are involved in the sonar targets, the scientists participated in a cruise aboard the Jordan December 13-22, using electrical sound sources from a ship dead in the water.

Dr. Holliday's approach to this problem is to develop a practical application of the "resonant frequency" technique.

Since some fish, including anchovy, have swim bladders--little pockets of gas that help them to stay afloat--Dr. Holliday proposed to bounce sonar waves off these fish. The swim bladders should give definitive responses indicating the size of the bladders and hence the size of the fish. Putting this information together with such other factors as the depth of the fish, the time of year, the geographical location and other factors--it should be possible to identify the species of fish, its stage of development and numbers.

On this cruise, the first of a series of four cruises, Dr. Holliday, aided by Mr. Hewitt and Dr. Smith, used a towed arcer on loan from the University of Southern California as a "broad band" sound source to determine the presence of airbladders and to estimate the size of the air bladder. The towed array and spectrum analysis equipment was assembled for this test by Tracor. The results thus far are promising. According to Dr. Holliday, they achieved a useful tow speed of 6 knots which is adequate for local analysis of the northern anchovy stock.

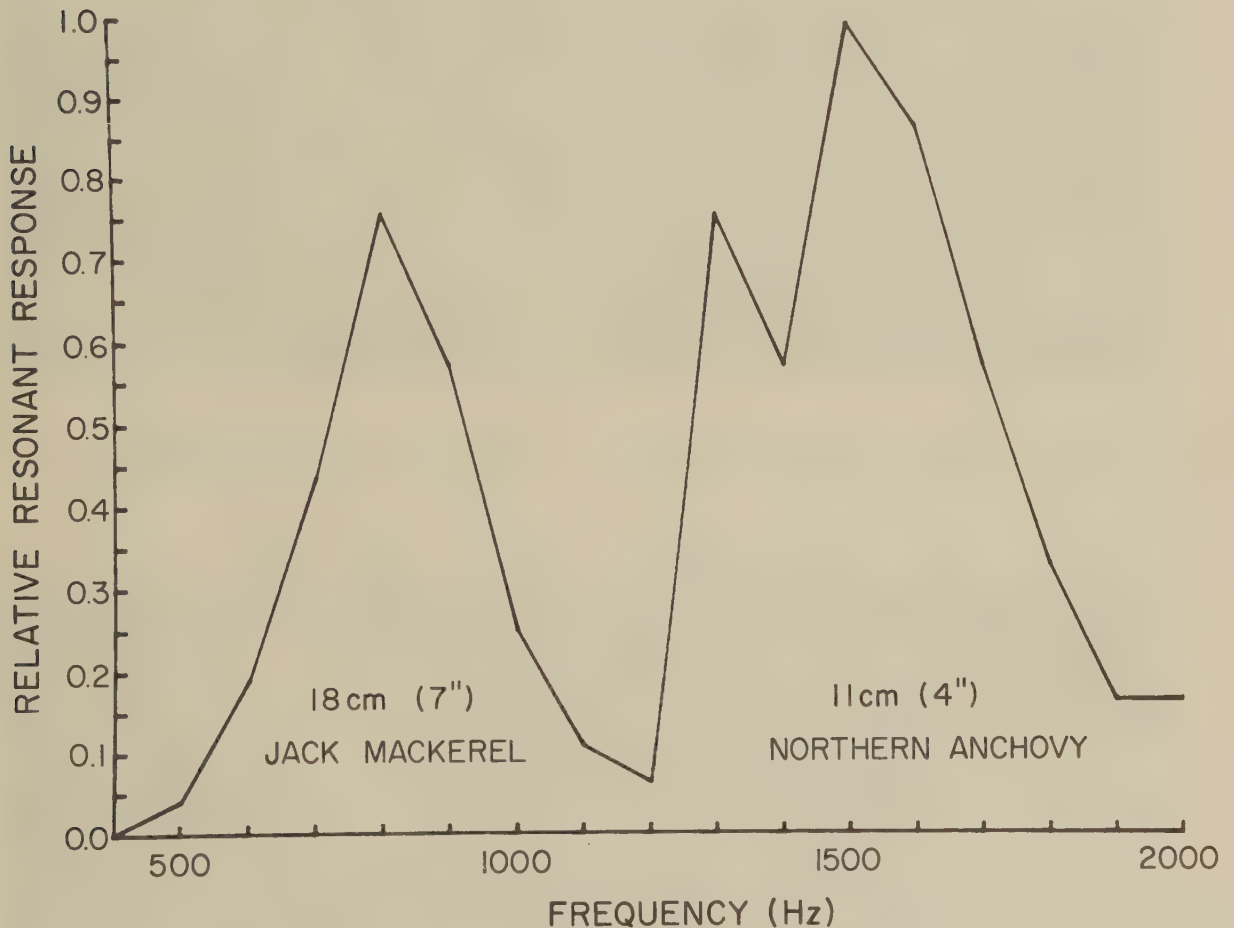


Figure 1 -- This curve is the measured resonant response from a school of fish which contains individuals from two size groups and two species. The relative response at each frequency is the ratio between the sound emitted by the source and the second returned by the air bladder of the target. Non-resonant targets in this situation return a sound which does not deviate from a horizontal straightline. Fish indicated on this figure were collected from a directed set of a purse seiner on the school being insonified. Later, the fish were identified, measured and matched to their resonant peaks (Holliday, 1972).



Dr. Paul Smith, shown above pointing to towed source and towed array suspended off albacore trolling rig. At left is Mr. David Horton, engineer with Tracor.



Dr. D. V. Holliday, Tracor Sciences and Systems Co., inspecting resonant frequency graphic display aboard Jordan.

Oceanic Fisheries Resources Division

PORPOISE/TUNA PROGRAM

NOAA Vessel, Surveyor, Used for "Ground Truth"
Survey of Porpoise Schools

The NOAA research vessel, Surveyor, was engaged in a "ground truth" survey in the eastern tropical Pacific, November 15-December 9. The purpose was to study the relationships (by comparison) of porpoise school sightings recorded concurrently by observers on board ship, on board a helicopter, and captured on film from the helicopter. In addition, Chief Scientist Dr. David Au, aided by Lt. Wayne Perryman, NOAA Corps Officer and Messrs. Frank Ralston and Dale Powers, all of the La Jolla Laboratory, studied the behavior of dolphin schools relative to the approaching ship and the effects of that behavior on school detecting and counting.

According to Dr. Au, the scientific party maintained a marine mammal watch between November 18 and December 8. Twenty-eight porpoise sightings were recorded, of which 21 were identified to species. Seventeen whale sightings were recorded of which four were identified to species.

The use of the helicopter to track the behavior and path of porpoise schools relative to the approaching ship was successful. Eight schools were tracked with the helicopter-ship radar tracking system. The behavior of these schools was recorded by movie and still photography from the helicopter. The helicopter team also recorded characteristics of the porpoise schools for comparison with those recorded by the ship team.

Aerial-Ship Survey to Estimate Porpoise Populations

A massive aerial-ship survey to estimate the porpoise populations in five million square miles of the eastern tropical Pacific will begin in early January 1977. The object of the survey, to be coordinated by Dr. Eric Barham and the staff of the Porpoise/Tuna Interaction program at the La Jolla Laboratory, is to better understand the impact of the commercial tuna fishery on these porpoise populations.

Estimated to cost a third of a million dollars, the survey is the result of a year's intensive planning by U.S. government fishery biologists and population experts, assisted and advised by the U.S. tuna industry, the Marine Mammal Commission, environmental groups, and other authorities on porpoise biology.

The survey operations involve an aircraft and two research vessels operated by NOAA. A Navy-loaned Neptune (SP-2H) from the Office of Aircraft Services of the U.S. Department of the Interior is the primary survey vehicle covering most of the designated ocean area. The remaining areas are being covered by the NOAA research vessels, David Starr Jordan, from San Diego, and the Townsend Cromwell from Honolulu. Fishery biologist Dr. David Au of the La Jolla Laboratory is the chief scientist for the surface operations.

The at-sea operations will begin January 4 and the aerial effort on January 17. Six trained aerial observers--five from NMFS and one from the Naval Undersea Center, will survey from the Neptune during its 30,000 nautical mile (55,590 km) journey, lasting 45 days.

To obtain desired coverage of the vast ocean area, the long-range Neptune will be flying from airports spaced along the western boundary of the Americas, from California to Ecuador, and from airfields in Hawaii and French Polynesia. Dr. Barham estimates total flying time as 326 hours, of which approximately 176 hours will be actual observations. The plane is scheduled to fly at 1,5000 feet (457 m) on a pre-arranged track. A total of 25 tracks will be flown, each of which is about 1,100 nautical miles (2,038 km).

When a porpoise school is sighted, visual estimates will be made by the two observers on watch and the data recorded by another observer riding in the plastic nose of the plane. Pictures will be taken with a 9-inch mapping camera. The airplane will then drop to about 500 feet (152.5 m) above the ocean to make species identification with 15-power gyro-stabilized binoculars and 35-mm camera. When this maneuver is completed, the plane will then climb to the 1,500 foot evaluation and resume the trackline. Accurate positioning of the porpoise school is made through the Global Navigational System which is capable of accuracy to 1/10 of a nautical mile.

At sea, the Cromwell and Jordan will each carry five scientists trained to sight porpoise. During the daylight hours, a constant watch will be maintained with 10x20 binoculars mounted on the flying bridge where the observers will look for bird flocks and other evidence indicating the presence of porpoise.

The Cromwell is scheduled to travel 12,000 nautical miles (22,236 km) over a period of 72 days to survey the western-most boundary of the area where these porpoises may be found. The Jordan's job is to cover the southwest boundary of porpoise distribution, somewhat east of the Cromwell's track, running about 12,200 nautical miles (22,606 km) during 61 days at sea.



Standing in front of the Navy-loaned P2V Neptune (N48347) from the Office of Aircraft Services (OAS) of the U.S. Department of the Interior are members of the crew and observers participating in the aerial survey.

From left these are: Dan McGeehee, OAS, Anchorage, Co-pilot; Eric Barham, Chief Scientist, La Jolla Laboratory; Charles Oliver, La Jolla Laboratory; James Coe, La Jolla Laboratory; Steve Leatherwood, Naval Undersea Center, San Diego; Joe Powers, La Jolla Laboratory; Terry Jackson, NOAA Corps stationed at the La Jolla Laboratory; Richard Charter, La Jolla Laboratory; Lucien Caulkett, OAS, Anchorage, Co-Captain; Thomas Bileau, OAS, Anchorage, Co-Captain. Missing from the photograph is William Walker, La Jolla Laboratory.

TUNA RESOURCES PROGRAM

The sixth annual meeting with fishermen participating in the NMFS cooperative facsimile advisory (FAX) program was held at Portuguese Hall on December 14, 1976. The announcement of the meeting was sent to more than 100 skippers and navigators of the tropical tuna fleet; 15 fishermen representing 16 tuna vessels attended.

The meeting was chaired by Mr. Richard Evans, Oceanographer at the La Jolla Laboratory, who conducted the event in an informal manner with frequent interchanges between the speakers and audience. The fishermen indicated general satisfaction with the FAX products but suggested, either individually or as a group, the following modifications: Include low and high pressure centers, especially near the Yucatan Peninsula; provide a weather forecast rather than an analysis; provide satellite coverage of frontal patterns where possible; either improve the accuracy of the sea state chart or eliminate it.

In addition to Mr. Evans who discussed the FAX program overview for 1977, others who made presentations to the group included: Mr. Forrest Miller of the Inter-American Tropical Tuna Commission (under contract to the Southwest Fisheries Center) who discussed environmental factors affecting fishing activities; Mr. Emil Gunther, tropical forecaster, who told the group about preparation of facsimile products at the National Weather Service Forecast Center, Redwood City; Mr. Leonard Snellman, Chief, Scientific Services for the National Weather Service, Salt Lake City who, with Mr. Gunther, presented information on tropical storm development as viewed from satellite photos; and finally, a talk was given by Mr. Mark Sweeney of the La Jolla Laboratory on FAX program equipment maintenance and dissemination of supplies.

The fishermen present indicated that they found the presentations interesting and worthwhile.

Next year's meeting will be hosted by Mr. Jim Steiner, Meteorologist-in-charge at Lindbergh Field, on behalf of the National Weather Service.

Inflationary Impact Statement Prepared for Rules for Incidental Take of Marine Mammals in Yellowfin Tuna Fishery

After returning from a trip down the California coast in conjunction with the anchovy/jack mackerel (December 3), Dr. Dan Huppert, economist at the La Jolla Laboratory, spent most of December in preparing an "Inflationary Impact Statement" for the proposed Rules for the incidental take of marine mammals in yellowfin tuna purse seine fishery. This report is required by Executive Order 11821, and must be certified as completed when final rules are published in the Federal Register. A draft of the report was reviewed by some industry sources and was submitted to the central office of the National Marine Fisheries Service in Washington on

December 21. Revisions and adjustments were made during the week of December 27-31, and alterations in format and language were still being made in Washington as of this writing. Copies of the report will be available when it is completed.

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The November issue of "Fishing Information" was sent to press on December 22, according to La Jolla Laboratory fishery biologist J. Renner, editor of the publication. Two 15-day supplement charts to the December issue were also produced and distributed to subscribers.

"Fishing Information" is a regular publication produced by the staff of the La Jolla Laboratory and distributed to fishermen, researchers, fish buyers and others that have need for environmental information from the North Pacific.

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Conversion of sea surface temperature monthly base charts from the Fahrenheit to the Celsius scale was completed for the eastern North Pacific by month's end. These charts will eventually be used in future publications of "Fishing Information" when it begins reporting all measurements in metric units.

PACIFIC ENVIRONMENTAL GROUP

OCEAN MODELING AND FORECASTING

Thesis Research Uses Long-Term Oceanographic Data to Develop Models Describing Observed Variation in Recruitment of Pacific Mackerel

Dick Parrish, fishery biologist of the Pacific Environmental Group, Monterey, has completed all requirements for the degree of Doctor of Philosophy in Fisheries from Oregon State University. In his research, Dr. Parrish used long-term oceanographic and meteorological data to develop models that describe the observed variation in the recruitment of Pacific mackerel (*Scomber japonicus*) in the California Current region. The models that were found to best describe recruitment included both density-dependent factors and environmental factors. Models incorporating only density-dependent factors accounted for a maximum of 24% of the observed variation in recruitment. Multiple regression models including both density-dependent and environmental-dependent factors were fitted to the data available for two time periods; 1931 to 1968 and 1946 to 1968. A model including three environmental factors and a density function was selected as the best fit to the longer period.

In this model increased recruitment was associated with increased sea surface temperature, reduced sea level, and reduced atmospheric pressure during the spawning season. This model accounted for 59% of the variation in recruitment from 1931 to 1968. The model fitted to the 1946 to 1968 period included a density function and two environmental factors, on which data was not available prior to 1946. Increased recruitment with this model was associated with increased coastal upwelling and decreased off-shore convergence during the spawning season. This model accounted for 76% of the variation in recruitment from 1946 to 1968.

Yield per recruit simulations gave greatly different results than dynamic pool simulations. Maximum yield with a yield per recruit model occurs with an age at recruitment of 1 or less and instantaneous fishing mortalities (F) in excess of 1.0. Dynamic pool simulations that incorporate a Ricker spawner-recruit function predict that extinction of the stock will occur with the above fishing strategy. Dynamic pool simulations with both density-dependent and environmental-dependent recruitment functions were assessed to determine maximum yield with different ages at recruitment and different quota options.

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Mr. David M. Husby, Oceanographer at PEG, travelled to San Francisco to present a paper at the Fall Annual Meeting of the American Geophysical Union, 6-10 December 1976. A broad range of oceanographic topics was presented at the meeting.

Of particular interest to the National Marine Fisheries Service were the results presented during the sessions dealing with NORPAX and general ocean numerical models. The emphasis was on monitoring and modeling large-scale, long-term variability in the upper layers of the ocean. Mr. Husby's paper described a method to summarize open ocean hydrographic data in a format useable for the analyses of changes in the vertical structure of the ocean.

In his presentation, entitled "Fourier Analysis of Subsurface Oceanographic Time Series - A Numerical Smoothing and Analysis Technique," Mr. Husby described how classical harmonic analysis was performed on the time series of subsurface temperature, salinity and depth at constant density (σ_t) values at Ocean Weather Station "V" for the period January 1966 to January 1972. A fundamental period of 366 days was used and the detrended daily values at constant σ_t values (at $0.2d_t$ intervals) were analyzed. The Fourier series at each σ_t level was used both as a quality control device on the original time series and as a low-pass filter to summarize temporal variations within each year. Comparison of the observed data with the least-squares Fourier fit quickly revealed anomalous values which may be due to poor vertical sampling or lateral mixing along the σ_t surface. The standard errors of estimate for the Fourier series expansions ($n = 12$) ranged from 0.06° to 0.19°C and from 0.01 to 0.05 ppt for temperature and salinity, respectively. The Fourier series expansions provide

smoothed daily, weekly, monthly or seasonal values and can be used to estimate rates of change of properties at selected levels, in particular, changes in the heat content of the water column at various time scales.

OCEAN CLIMATOLOGY AND MONITORING

Assistance Given in Establishment of Water Sampling Program to Measure Hydrocarbons

Mr. Paul Sund, Coordinator of NMFS Platforms of Opportunity Programs, has been assisting the staff at the Tiburon Laboratory with the establishment of a water sampling program to measure hydrocarbon concentrations in San Pablo Bay. Mr. Sund and Brian Jarvis are trying to develop and fabricate sampling equipment for hydrocarbons that can be used from California Maritime Academy (CMA) vessels for a cooperative water sampling program. CMA will provide vessel time and midshipmen who will take the samples. Brian Jarvis will act as liaison between the Tiburon Laboratory and the CMA.

TIBURON LABORATORY

PHYSIOLOGY INVESTIGATIONS

Experiments with Striped Bass Larvae Show Interesting Growth and Energy Utilization Trends

A report on research performed during last year's striped bass spawning season and on a preliminary conceptual model for the striped bass population in the San Francisco Bay-Delta estuary will be presented at a meeting of the San Francisco Bay and Estuarine Society at the California Academy of Sciences on January 13. Information on the effects of food and salinity on striped bass early stages will be presented by Maxwell Eldridge, Fishery Biologist at Tiburon. Mr. Eldridge's talk will also include a description of major developmental events using a series of colored photomicrographs. Dr. Jeannette Whipple, Task Leader, will present the conceptual model which was derived through the cooperation of individuals on a state-federal agency committee (CDF&G, CDWR, F&WS, BOR, NMFS).

Processing of laboratory data from experiments with striped bass larvae is approximately two-thirds complete according to Dr. Whipple and shows some interesting growth and energy utilization trends. Striped bass larvae began feeding 8 days after fertilization. Those larvae initially fed rotifers did not grow in tissue dry weight or standard lengths until food type was changed to brine shrimp, when their subsequent growth quickly assumed that of larvae fed brine shrimp from the beginning. Older larvae feeding on brine shrimp or copepods (Cyclops sp.) did not grow at different rates.

Starved larvae maintained a standard length of 5.6 mm from day 8 until near death on days 29 and 30. By day 30 their size was reduced to a mean of 5.4 mm.

Larvae reared in fresh water had lower survival rates than those reared in partial sea water (11-13 ppt). Their sizes, in dry weight and standard lengths, were also smaller. Larvae in fresh water and starved, died in approximately 12 days.

Yolk was consumed before the oil globule was as a metabolic substrate in striped bass embryos and yolk sac larvae. It was totally absorbed by the beginning of feeding. Thereafter, the oil globule decreased in size and dry weight. In larvae given food the oil globule lasted for approximately 19 to 23 days after fertilization. The differences in utilization of oil between starved and fed larvae were detectable after day 14. Starved larvae were able to conserve their oil until death.

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A new Task Development Plan (TDP) for FY 1979 was completed for submission by Maxwell Eldridge entitled "Striped Bass Culture: Inducement of Spawning in Captivity; Development of Formulated Food for Larvae; Salt-water Pen-rearing." This TDP outlines research closely related to current striped bass studies at the Tiburon Laboratory and is designed as a feasibility study. Technician Jack Scholl has been hired as a culturist to rear species of phytoplankton and zooplankton for the larval striped bass.

OCSEAP Petroleum Research Task

Final preparations were made by Dr. J. Whipple and Thomas Yocom to hold a meeting at the Tiburon Laboratory of scientists in the San Francisco Bay area involved with petroleum hydrocarbon research. The meeting, to take place on January 3, 1977 is designed to be a forum where each investigator makes a short presentation describing his research interests and the major results of research in progress.

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A supply of Alaska crude oil (from ERL) needed for experiments and originally scheduled to arrive in Tiburon by late November, had not arrived by the end of this month. Additional oil was requested from a source in Alaska (through the Auke Bay Fisheries Laboratory) and it is hoped that it will arrive before the present supply is exhausted.

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Preparation for future experiments were complete in December. Three additional crude oil solubilizers were constructed and final tests were made on the existing solubilizer. Approval was received to order a stainless steel pump for the laboratory sea water system, the salinity control was repaired, and the laboratory lighting was placed on an automatic timer to simulate the natural photoperiod.

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Attempts to collect juvenile starry flounder during the month at Tomales Bay with an otter trawl were unsuccessful. Subsequently, it was arranged to have a commercial trawler provide us with an adequate supply.

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Dr. Whipple and Pete Benville prepared for an experiment testing the effect of 100 ppb WSF of Cook Inlet crude oil on starry flounder gonadal maturation and spawning. Effects on behavior gamete mortality, cytoplasmic differentiation and maturation, lipid content and sperm mortality will be assessed. If spawning occurs, or artificial fertilization is successful, the effects on survival through hatching and yolk absorption will also be measured. This experiment is being coordinated with Dr. Walter Kuhnhold of the NEFC, Naragansett Laboratory who will do a similar experiment testing the effects of #2 fuel oil (100 ppb) on winter flounder from the east coast.

Petroleum Hydrocarbon Magnification in Fish Larvae
Through Their Food Documented for First Time

The first draft of the manuscript "Fate of ^{14}C -Benzene in Pacific herring (*Clupea harengus pallasi*) eggs, yolksac larvae and feeding larvae" by M. Eldridge, T. Echeverria and S. Korn was completed. The paper reports that all three early life stages rapidly accumulated ^{14}C -Benzene to levels approximately 10 times the exposure concentrations within 6 to 12 hours after a single aqueous exposure. Benzene was then released at a slower rate to approximate exposure concentrations at 48 to 72 hours after exposure. By exposing feeding larvae to benzene through various combinations of food and water, it was determined that larvae first accumulated benzene from the water, began to depurate it, then initiated a secondary uptake from ingested contaminated rotifers. Previous experiments had shown that the marine rotifer, Brachionus plicatilis, did not readily metabolize or depurate benzene, but rather accumulated it to constant and relatively high levels. This hydrocarbon accumulation between two important trophic levels in the food chain is the first documentation of petroleum hydrocarbon magnification in fish larvae through their food.

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Maxwell Eldridge and Dr. Whipple have been working on the development of a model for energy utilization in herring embryos and larvae during three developmental stages. The effect of benzene at chronic low levels on the energy utilization is considered in the context of the model for the unexposed control larvae. The results and model are included in a manuscript entitled, "Energetics of Pacific herring (*Clupea harengus pallasi*) embryos and larvae exposed to low concentrations of benzene, a monoaromatic component of crude oil."

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Dr. Whipple prepared a paper to be presented at the meeting of the Oregon Chapter of the [Transactions] American Fisheries Society to be held at Kah-nee-ta, Oregon on January 27th. The paper will be presented in a session called "Selected Topics in Environmental Toxicology" and is entitled "Potential effects of chronic estuarine hydrocarbon pollution on spawning fishes."

COASTAL FISHERIES INVESTIGATION

King Salmon Tagged and Released

All king salmon remaining in the pen (4,263) at the Tiburon Laboratory after last month's storm were released this month. Of these, 2659 were tagged (those over 180 mm fork length). A high incidence of sores and scars was noted during tagging. It appeared these might have originated when the fish were transferred by fish pump from one pen to another last month, even though no pump-related injuries have been noted in the past.

Anglers' Guide to the United States Pacific Coast

During the month, the camera-ready art for the Anglers' Guide fishing facility tables and cover design was completed. Also, the second set of page proofs was received from NMFS' Scientific Publications Staff in Seattle.

The Anglers' Guide, co-authored by James L. Squire at the La Jolla Laboratory, and Susan Smith at the Tiburon Laboratory, describes marine game fish, fishing grounds, and fishing facilities along the coasts of California, Oregon, Washington, Alaska, Hawaii, American Samoa and Guam.

COASTAL FISH COMMUNITIES INVESTIGATIONS

Blue Rockfish Complete Period of Feeding on Algal Reproductive Tissue

During recent months the predominant large alga of the northern California coast, Nereocystis, has been releasing zoosporangial sori as part of its normal reproductive cycle. After developing as part of certain blades of the kelp plant, the sori, when mature, drop out and drift to the sea floor. At this time these structures become the major food of blue rockfish, Sebastes mystinus, that live in these kelp forests. Investigating this phenomenon, Dr. Edmund Hobson, Leader of the Fish Communities Task, and Fishery Biologist Tony Chess of the Tiburon Laboratory, have found that during the height of release, sori have constituted 100% of the diet of blue rockfish examined from kelp forests in both Sonoma and Mendocino counties. The numbers of sori being released have declined sharply during the past month, however, and the rockfish have returned to other foods.

Preliminary Studies Underway for Planned Rockfish Sampling Program

Dr. W. Lenarz, Fishery Biologist at the Tiburon Laboratory, accompanied Mr. Patrick Tomlinson (December 13 - 15, 1976) to the ports of Marshall, Dillon Beach, Bodega Bay, Pt. Arena, Albion, Fort Bragg and Eureka to become familiar with the situations that will be encountered in a planned rockfish sampling program and to confer with personnel of the California Department of Fish and Game. Mr. Tomlinson is under contract to the Tiburon Laboratory to help design the rockfish sampling program which is due to start in March 1977, and which will produce age and species composition estimates. Dr. Lenarz reports that he was impressed with the variety of sampling situations in the different ports and believes that a considerable amount of planning and coordination will be necessary for the program to be a success.

PRESS RELEASE

- December 3 - "NOAA research ship Townsend Cromwell reports on experimental fishing in Northwestern Hawaiian Islands."

PUBLIC AFFAIRS

- December 14 - Sister Dale Brown and 13 students from University High School in San Diego visited the Center at La Jolla for an illustrated lecture on the research conducted here and a tour of the facilities.

SEMINARS

- December 6 - Dr. John A. McGowan, Scripps Institution of Oceanography presented a talk during the current seminar series at the La Jolla Laboratory entitled, "Oceanic productivity and breaking internal waves."

Mr. Peter Pownall, Editor, Australian Fisheries, Fisheries Division, Australian Department of Primary Industry spoke on "The Australian fisheries scene" at the Honolulu Laboratory.

HONORS AND AWARDS

- December 16 - Mr. Thomas Hida of the Honolulu Laboratory received a special achievement award.
- 11 - Mrs. Sally Kuba of the Honolulu Laboratory received a 15-year length-of-service award.

- December 21 - Susumu Kato of the Tiburon Laboratory received a 20-year length-of-service award.

MEETINGS AND TRAVEL

- December 3-11 - Mr. Shomura attended a skipjack tuna meeting sponsored by SPC/FAO/ICLARM at Noumea, New Caledonia.

- 6-9 - Dr. Doug McLain, Oceanographer, and Mr. David Husby, Oceanographer, traveled to San Francisco to attend a meeting of the American Geophysical Union.

- 8-9 - Computer Programmer N. Wiley traveled to Tiburon to consult with Tiburon Laboratory personnel on computer usage and services.

- 9 - Messrs. I. Barrett, R. Lasker, P. Smith and G. Stauffer were in Los Angeles for the California Fish and Game Commission meeting where the California Department of Fish and Game presented its anchovy management plan to the Commission.

- 12-15 - Center Program and Planning Officer D. Mackett in Washington, D.C. to attend a meeting of a national data management group.

- 14-17 - Ms. Margaret Domras, Administrative Assistant, PEG, traveled to SWFC, La Jolla, to confer with administrative staff concerning SWFC procedures affecting PEG.

- 15 - Acting Center Director I. Barrett traveled to Seattle to meet with Mr. Gordon Shadoan, Chief, Personnel Division, NASO and then to Portland, Oregon to attend the meetings of the Pacific Regional Fishery Management Council as a member of the Council's Scientific and Statistical Committee

- 15-16 - Mr. Shomura attended the Western Pacific Regional Fishery Management Council conference at the Hawaii State Capitol

- 16-18 - Mr. Barrett in Boulder, Colorado for a meeting of NMFS Center Directors.

VISITORS

Honolulu Laboratory

- December 7 (?) - Mr. Don Nelson from California State College was in to talk with Heeny Yuen and Dr. Andrew Dizon about telemetry.

- December 8 - M. Francois-Xavier Bard, Centre National pour l'Exploitation des Oceans, Centre Oceanologique de Bretagne, France.
- M. Bard spent 3 weeks at HL discussing stock assessment of North Pacific albacore with Dr. Jerry Wetherall and other HL staff members.
- Mr. A. Borgeson, NASO, Seattle
- 20 - Dr. Gary Sharp, IATTC, met with Mr. Shomura to discuss immunogenetic research on skipjack tuna.
- 21 - Mr. John McMahon, Director, Marine Options Program, University of Hawaii, met with Mr. Shomura and Dr. Skillman to discuss NWHI resource survey and assessment.
- 23 - Mr. and Mrs. Milton (Dorothy) Roll, La Jolla.

La Jolla Laboratory

- December 1 - Cdr. Carl Kieninger (F4), Washington, D.C.
- 2 - Mr. A.M. Vrooman, NMFS (F52), Washington, D.C.
- Dr. John Walsh of Brookhaven National Laboratory here to look over the Scripps research vessel, Melville, for possible charter by Brookhaven.
- Mr. C. N. Renwick of British Columbia Packers, Vancouver, who is interested in the potential for an anchovy fishery off Baja California.
- 8 - Mr. Floyd Anders, Deputy Regional Director, SW Region, Terminal Island.
- 20 - Mr. Ken Weinberg, University of Washington, Seattle, Washington.
- 29 - Mr. Ernest L. Mabrey, NOAA, NMFS, Washington, D.C.

Pacific Environmental Group

- December 7 - Dr. Dave Mountain, Lt. Greg Ketchin, Lcdr. John Hanna, and Lt. Jim Smith, U.S. Coast Guard Oceanography Unit, Washington, D.C.
- 16 - L. F. Bradley, Maj. W. W. Cannon, Naval Postgraduate School, Monterey.
- Ferren Lee Kildow, Wagner O'Day Services Specialist, Federal Technical Assistance Panel, Santa Cruz, Ca.

Tiburon Laboratory

- December 2 - Joan Gallagher, San Francisco State University
- Cdr. Karl Wm. Kieninger, NOAA Corps Liaison, NMFS,
 Washington, D.C.
- Glenn R. Van Blaricom and Brock B. Bernstein, Scripps
 Institution of Oceanography, La Jolla.
- 7 - Thalia Castro Berrera, Universidad Autonoma Metropolitana,
 Mexico, D.F.
- 8 - Dick Wilhelmsen and Don Keene, Pacific OCS Office,
 Bureau of Land Management, Los Angeles.
- D. R. Buhlen, Oregon State University, Corvallis.
- 14 - Marvin Jung, California Maritime Academy, Vallejo.
- 29 - Joshua Susaran, student, College of Marin, Kentfield,
 Jeff Goddard, student, UCSC.

PERSONNEL ACTIONS

- November 21 - Alicia K. Rhodes, Clerk-stenographer, EOD, Tiburon Laboratory
- 29 - Robert D. Haught, Ltjg. , NOAA Corps, EOD, Tiburon Laboratory
- December 6 - Donna H. Welch, Clerk-stenographer, permanent appointment,
 Honolulu Laboratory.
- 10 - Donald B. Majors, Biological Aid (Fisheries), temporary
 appointment, Honolulu Laboratory
- Susan Carlson, Physical Science Technician, termination,
 Pacific Environmental Group.
- 15 - Virginia L. Ishida, Clerk-typist, permanent appointment,
 Honolulu Laboratory
- 16 - James R. Faris, Lt., NOAA Corps, Separation (transfer to
 Miami), Tiburon Laboratory.
- 20 - Arnold Y. Suzumoto, Biological Aid (Fisheries), temporary
 appointment, Honolulu Laboratory.
- Martha E. Ture, Biological Aid, temporary appointment,
 Tiburon Laboratory
- Kathleen M. Fourre, Biological Aid, temporary appointment,
 Tiburon Laboratory

